Rice Breeding Gets Marker Assists

A hapless thing happened on the evolutionary path to today's rice varieties. Some valuable genes were lost. Now biotechnology offers a faster way to locate those genes in noncommercial varieties and deploy them into new varieties through conventional breeding.

"We expect the process, called marker-assisted selection, to become more useful as we acquire a more refined map of the rice genome," says geneticist Anna M. McClung who heads the ARS Rice Research Unit at Beaumont, Texas.

Here's how the process works: Scientists create maps of "markers"—DNA sequences in or near genes whose locations are known—and compare them with the occurrence of favorable traits. If the markers and traits appear together more often than would occur by chance, the locations of the genes for the desirable trait are likely to be near the markers.

Multiple genes usually govern a single trait of economic importance. The locations of these genes are called quantitative trait loci (QTLs). Once QTLs are identified, scientists conduct DNA tests on rice breeding lines to find out whether they have the desired QTLs. If so, marker-assisted selection enables the researchers to put these traits into new-variety development programs much sooner than if they used trial-and-error breeding to identify plants with good genes.

Two new low-amylose rice varieties were released to seed growers last fall after 5 years of study rather than the usual 7 to 10 years. McClung and W.D. Park, of the Texas Agricultural Experiment Station, College Station, developed the varieties, Cadet and Jacinto, with marker-assisted selection.

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This marker research stemmed from observations that the texture of cooked rice from some noncommercial rice varieties differed according to growth environment. The reason for these differences lies in a DNA sequence of a gene that encodes for an enzyme called granule-bound starch synthase (GBSS), which produces amylose—a component of starch. The amount produced varies with field temperatures. A rice plant with a high-amylose version of the GBSS gene may actually produce low amylose in a warm environment.

Working under a cooperative research and development agreement, ARS scientists and researchers of a leading food company discovered a genetic marker that would predict cooked rice texture. The scientists then identified seed lots from particular regions that can dependably produce grain with special cooked-texture traits.

While researchers selected crosses that produced rice best suited for parboiling, they also chose crosses with high yield, moderate height, blast disease resistance, and good milling qualities. Scientists examined the crosses to determine how each major enzyme involved in starch synthesis controls grain-processing quality.

"Although chemical analysis and near-infrared spectral instrumentation have traditionally been used to determine amylose content in rice, using such procedures to compare one breeding line with another can be misleading," says McClung. Analyzing genetic markers, on the other hand, unequivocally determines which genes are in a cultivar.

Beaumont researchers now use marker-assisted technology in their routine evaluations of rice quality. The lab screens some 8,000 rice strains a year for U.S. rice-breeding programs.

After their success in selecting rice for grain quality, the scientists plan to use marker-assisted technology to help breeders incorporate multiple genes for disease resistance, semidwarfism, and milling quality into new varieties.—By **Ben Hardin,** ARS.

This research is part of Plant, Microbial, and Insect Genetic Resources, Genomics, and Genetic Improvement, an ARS National Program (#301) described on the World Wide Web at http://www.nps.ars.usda.gov.

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